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In situ characterization of estuarine suspended in the presence of muddy flocs and pellets

Grace M. Cartwright
Virginia Institute of Marine Science

Carl T. Friedrichs
Virginia Institute of Marine Science

L. P. Sanford
Virginia Institute of Marine Science

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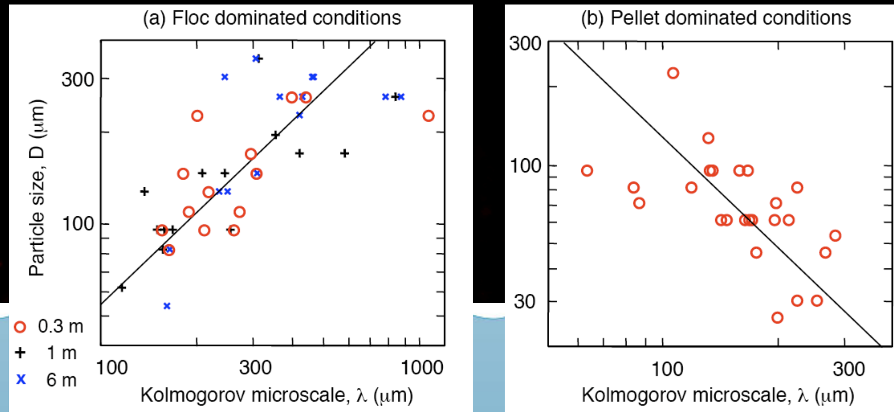
IN SITU CHARACTERIZATION OF ESTUARINE SUSPENDED SEDIMENT IN THE PRESENCE OF MUDDY FLOCS AND PELLETS

G. M. Cartwright, C. T. Friedrichs, and L. P. Sanford

$W_s \ \alpha \ D\rho$



Fugate and Friedrichs (2003)

λ ↓ Turbulence

Mud

D~ 5 – 10 μm

W_s< to <<0.1 mm/sec

Flocculants

D ~ O(λ)

Microflocs < 160 μm

Macroflocs >160 μm

↑ W_s ↑ λ ↑ % Organic

Fecal Pellets

D~ 10s – 100s μm

W_s ↑ λ ↓

W_s ~0.1–10 mm/s

Sand

D= 63 – 500 μm

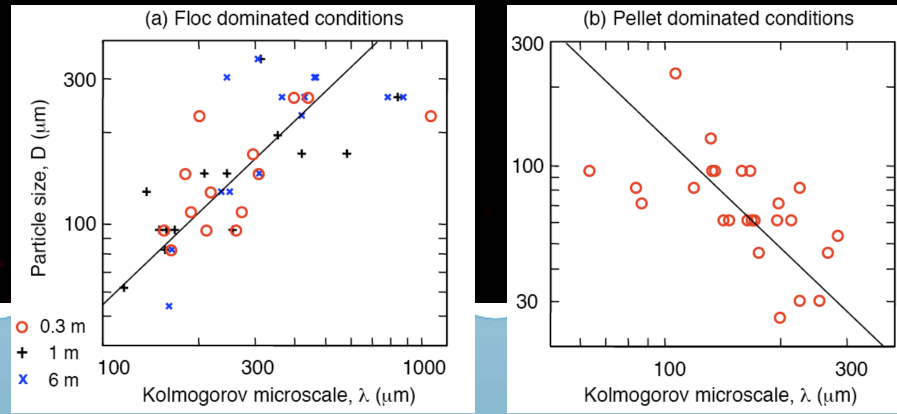
W_s = 2.3–60 mm/s

Settling Velocity

Anderson (2001), Sanford et al (2005) Sherwood (2007) Taghon et al (1984), Wheatcroft et al (2005)

$W_s \; \alpha \; D\rho$

$\lambda \downarrow$ Turbulence $\uparrow$



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Mud

D~ 5 – 10 µm

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Microflocs < 160 µm

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$\uparrow W_s \uparrow \lambda \uparrow$ % Organic

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$W_s \uparrow \lambda \downarrow$

W_s ~0.1–10 mm/s

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Settling Velocity

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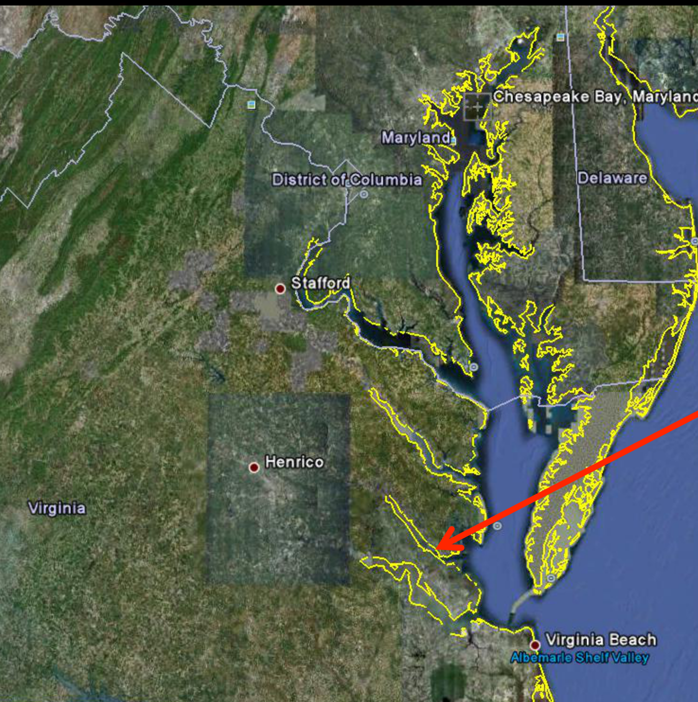
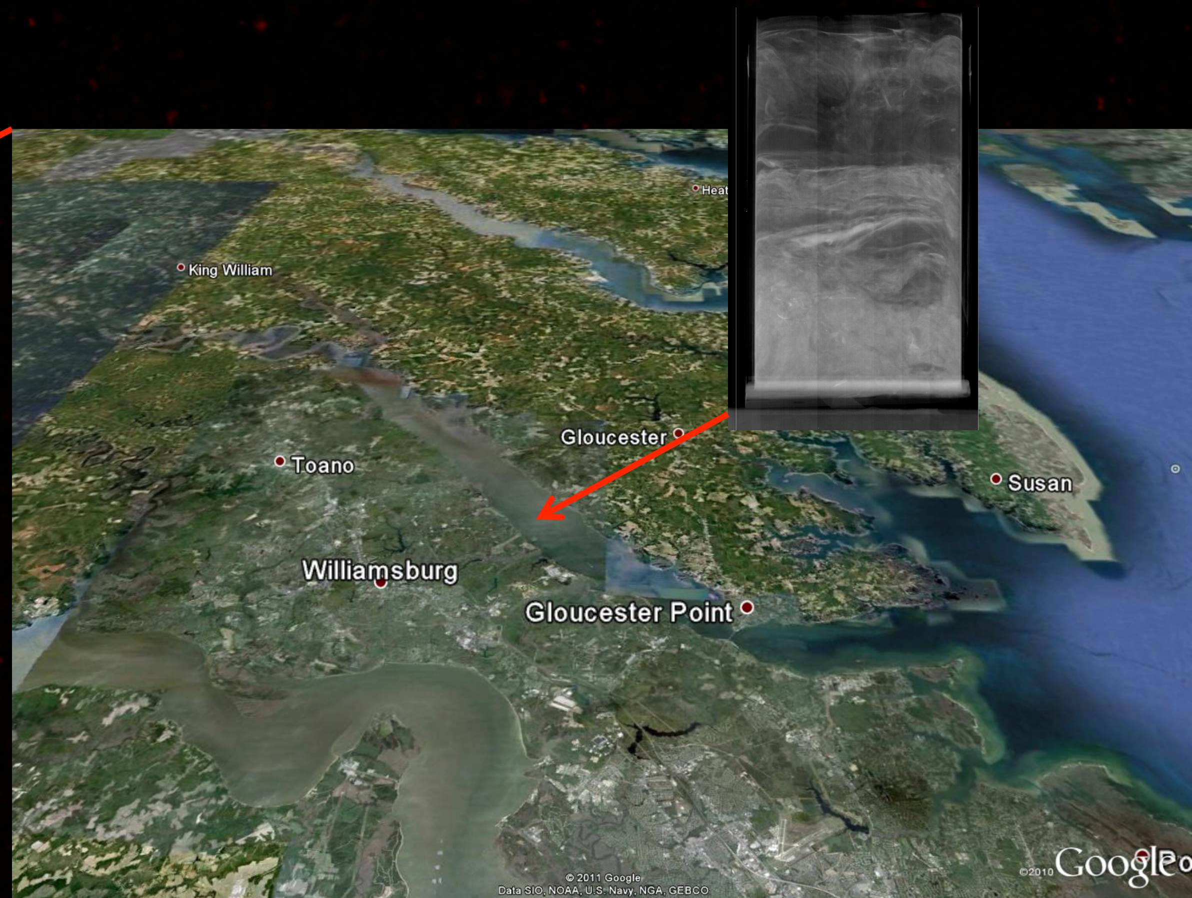
STUDY SITE

NSF MUltiDisiplinary Benthic Exchange Dynamics

Claybank area on York River
Chesapeake Bay, VA





Secondary Channel

~ 5 meter depth

Neap Tide

Seabed > 75% mud

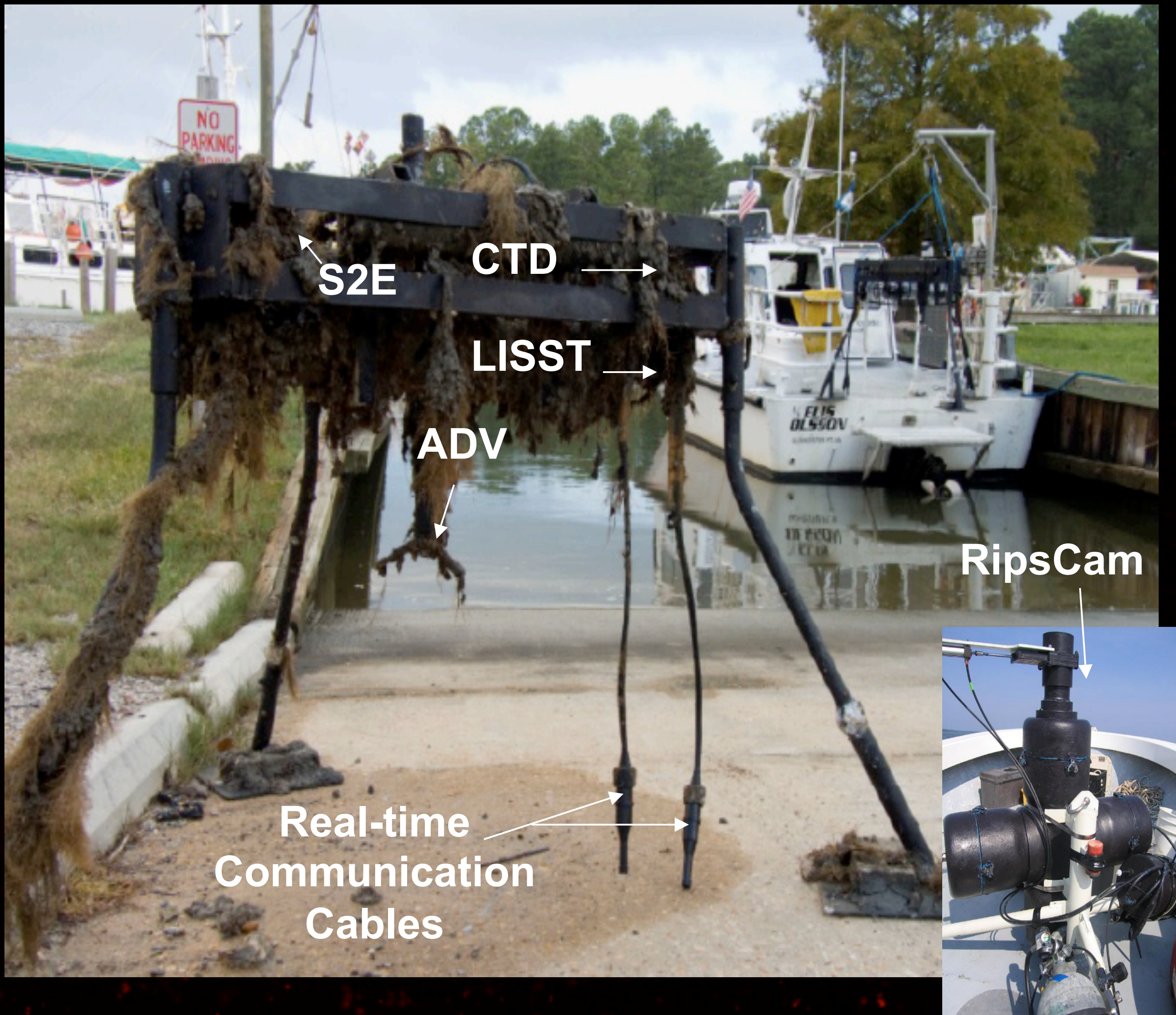
~10% Organics

Sand D50 ~100 µm

<30% Pellets

Kraatz, (2010, personal comm), Rodriguez-Calderon (2010)

METHOD



25 hour Study Period

LISST 100X

15 min burst interval
100 records @ 1 Hz
(10 samples/record)

Distribution measured
2.5 – 500 µm

RipsCam

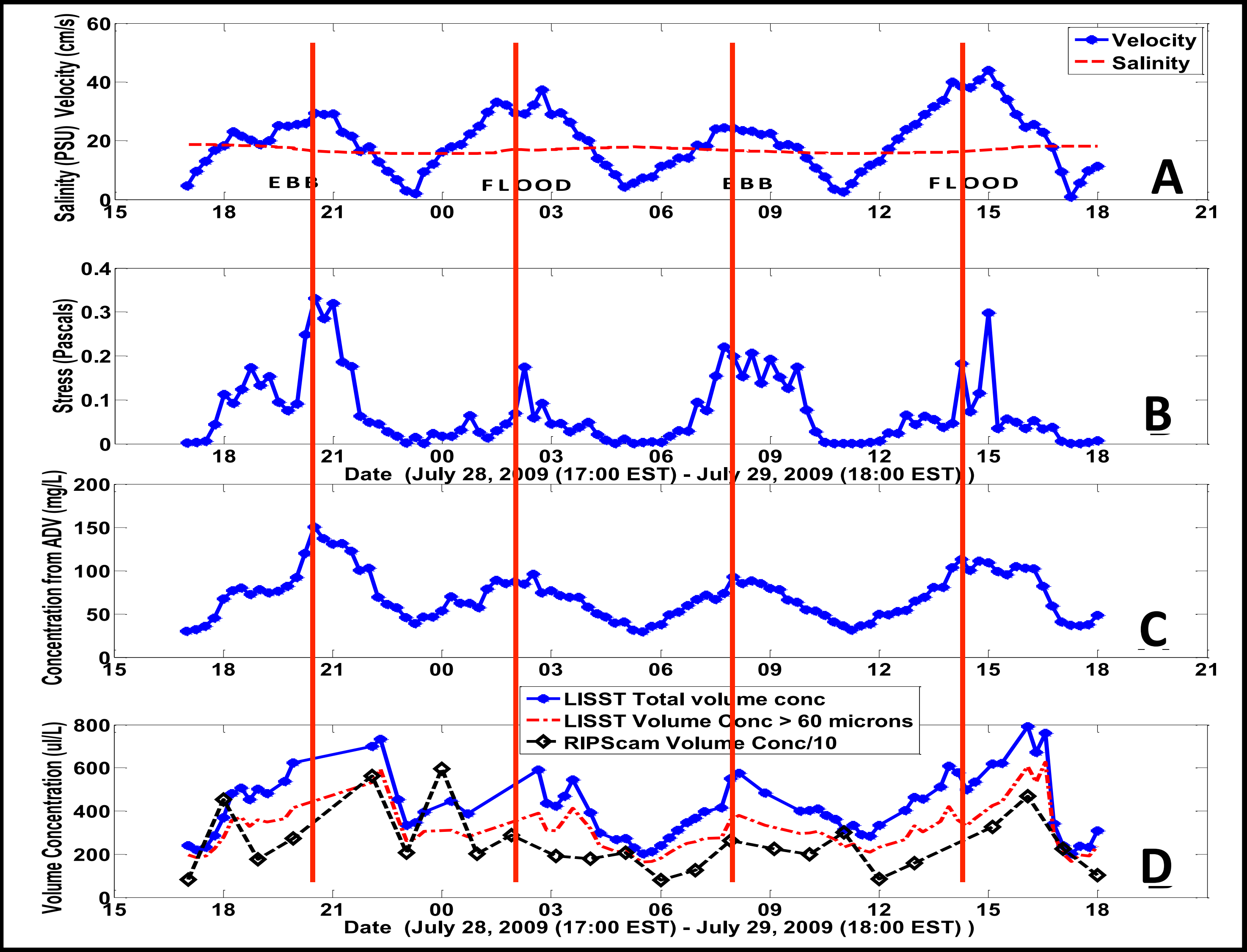
1 hour “burst” interval
5 flash exposures
at 1 min interval
Focal depth ~1mm

Distribution measured
~60 µm – 1.3 mm

ADV

15 min burst interval
2 min @ 10 Hz

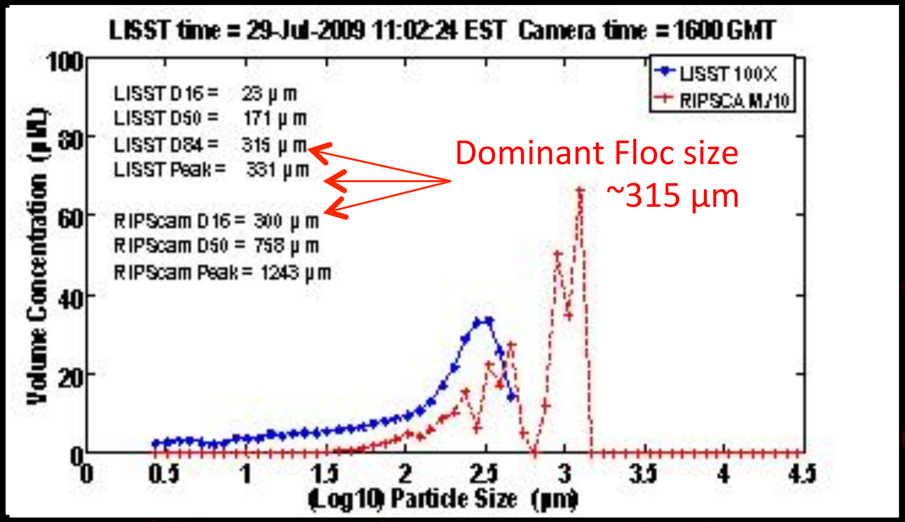
Currents, Stress and Concentration

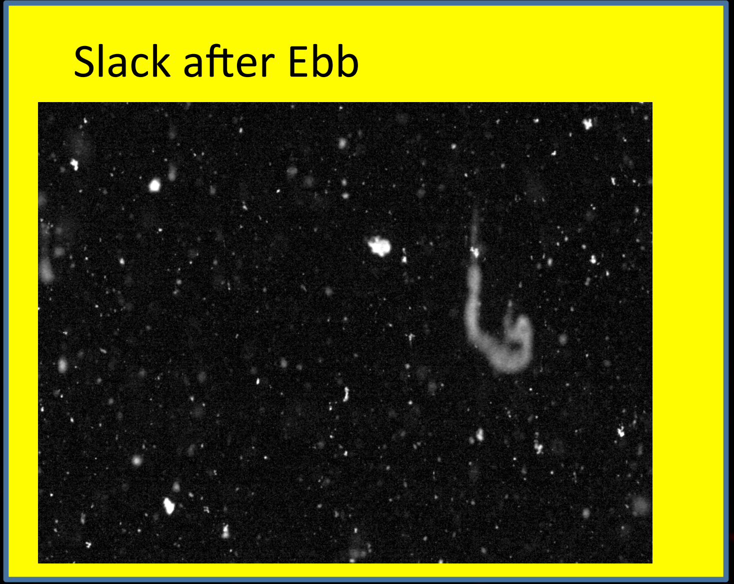


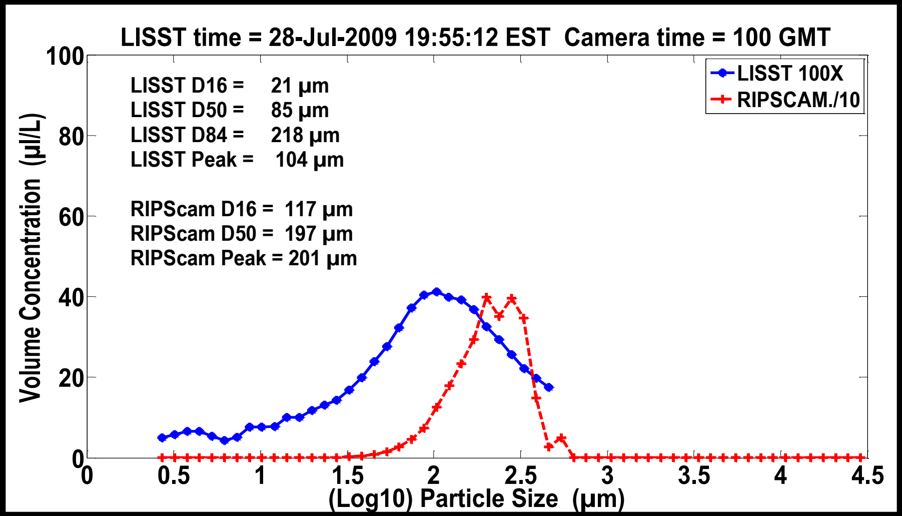
Concentration by weight(mg/L) corresponds with peak currents

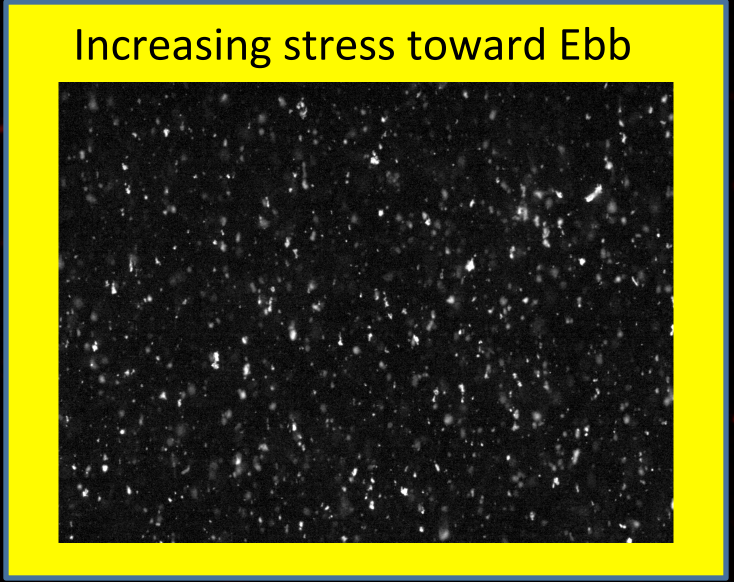
Concentration by volume (µm/L) doesn't

EXAMPLE DISTRIBUTIONS









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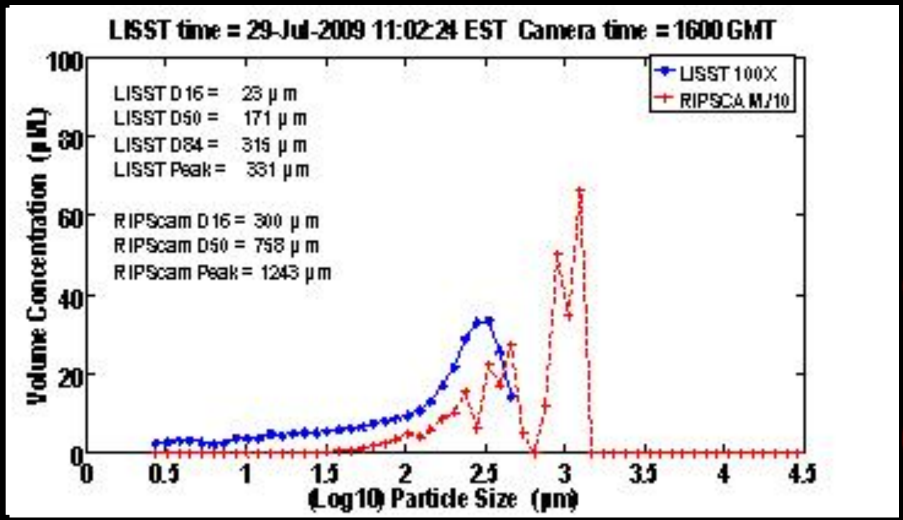

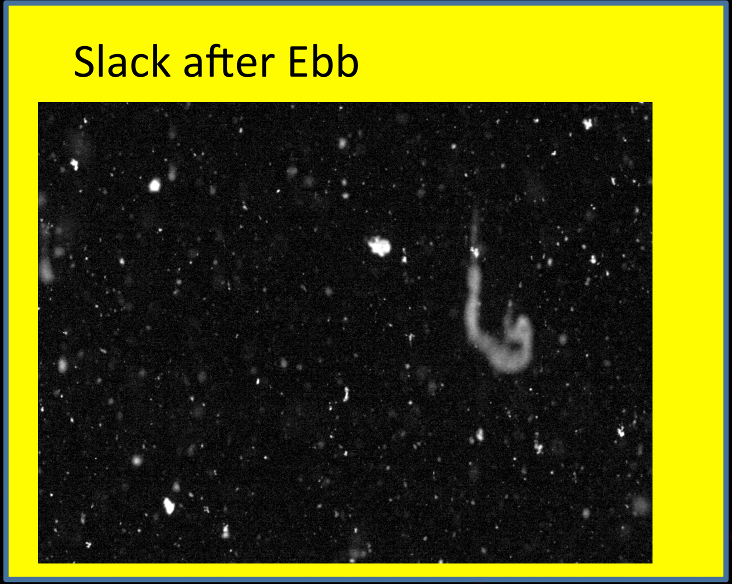

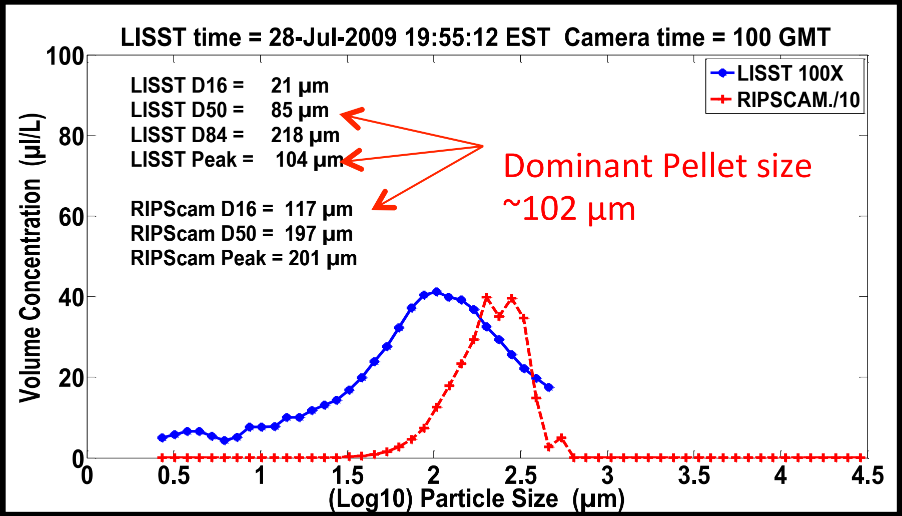

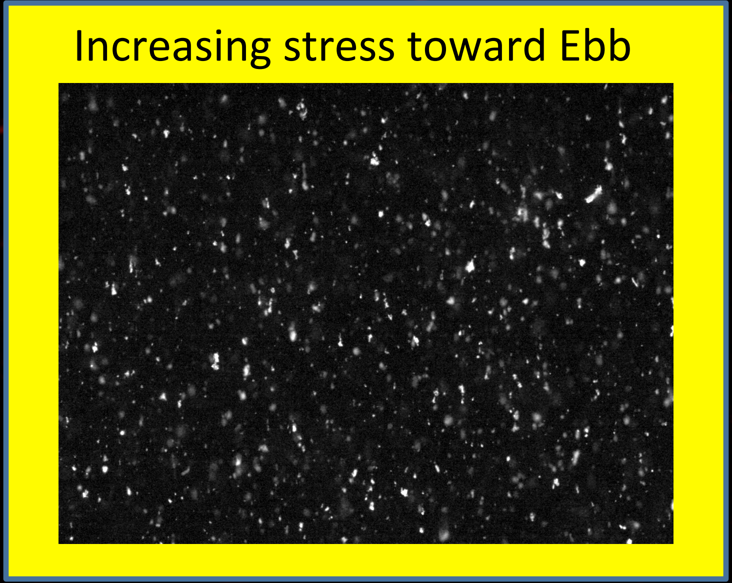

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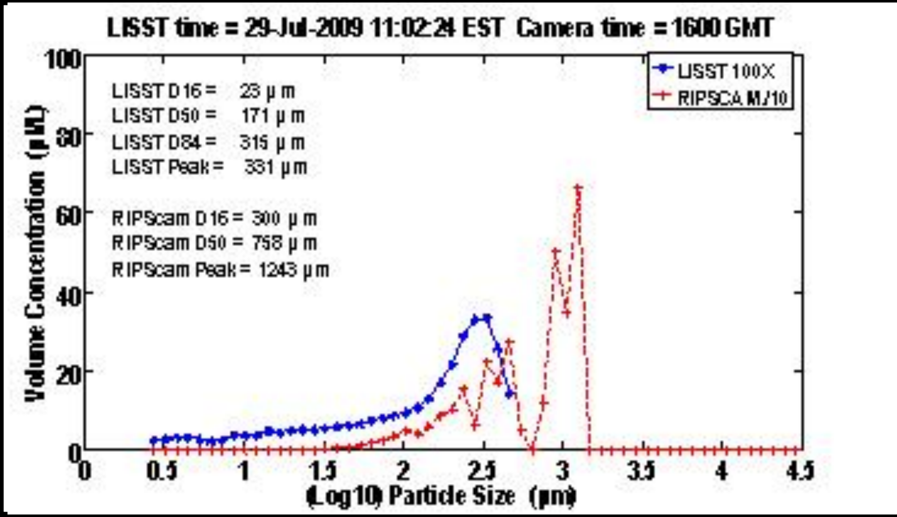
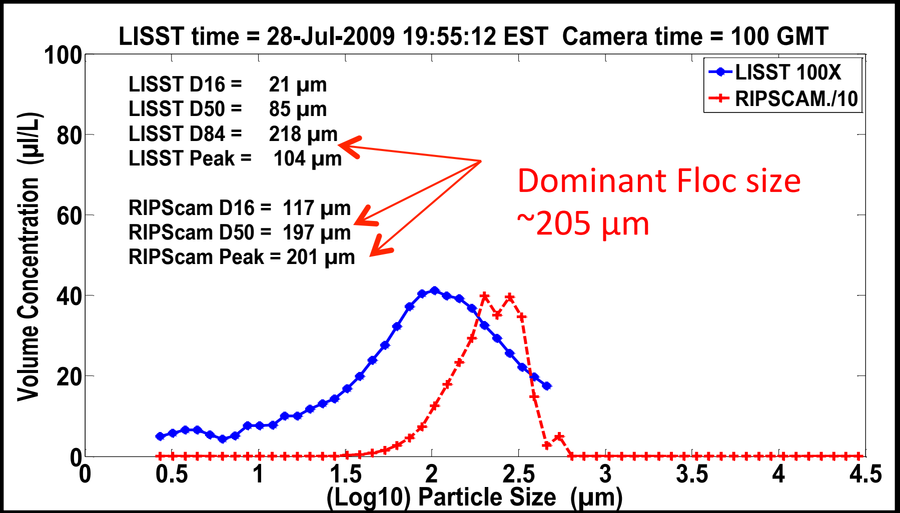
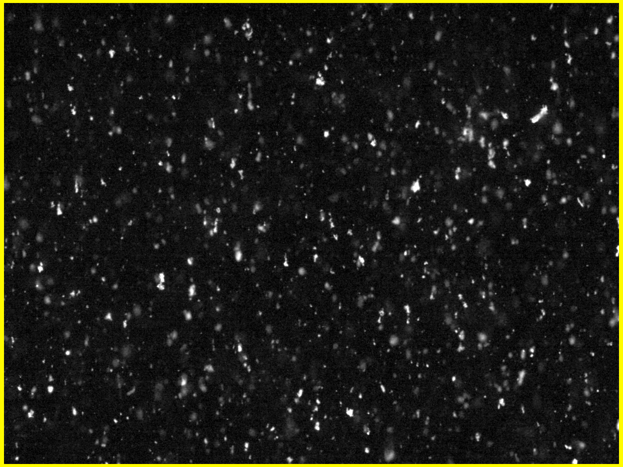


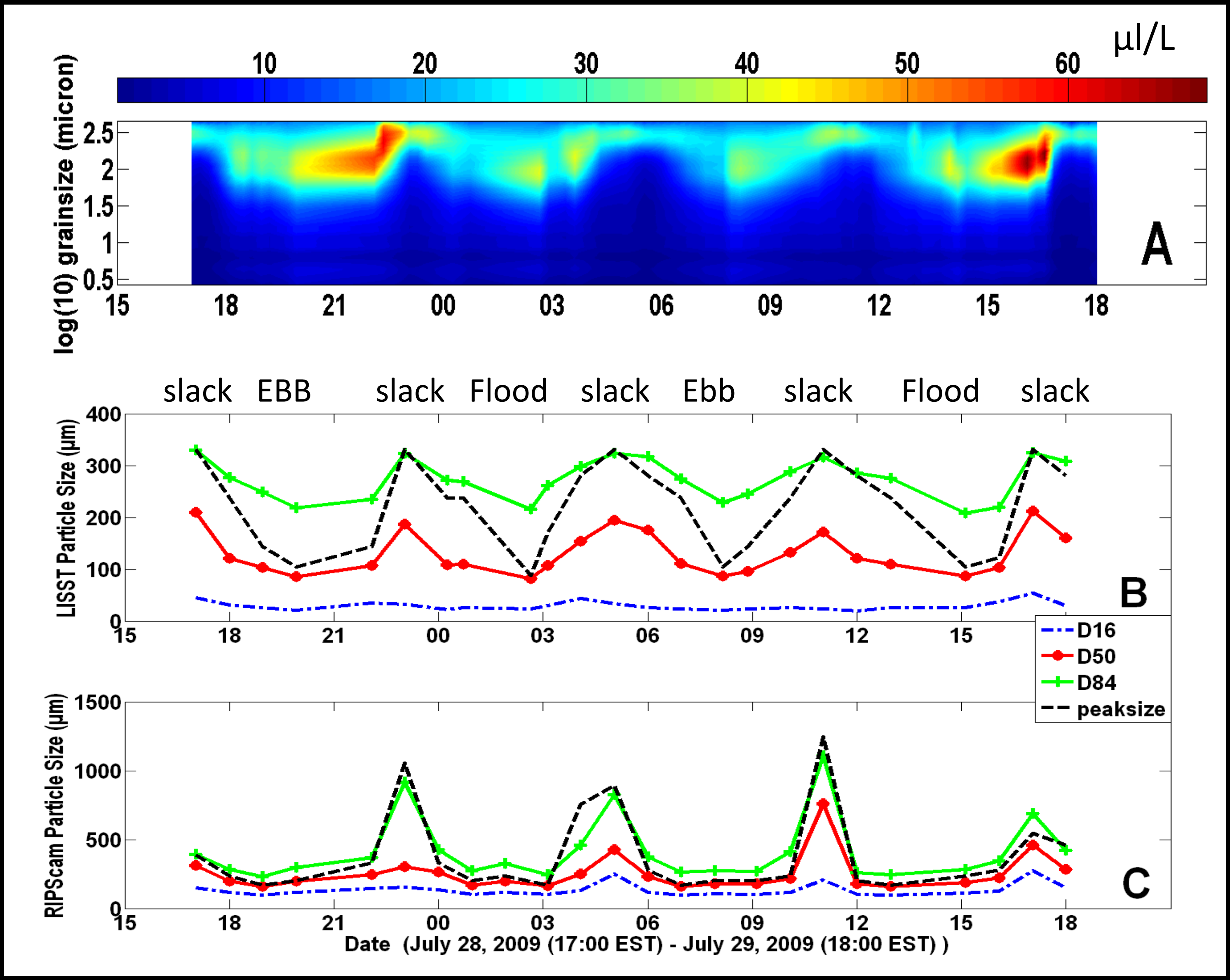
Slack after Ebb



Increasing stress toward Ebb



STUDY PERIOD DISTRIBUTIONS



Low Stress

Dominate floc size

~ 315 µm

LISST Peak
LISST D84
RIPScam D50

High Stress

Pellets

~ 102 µm

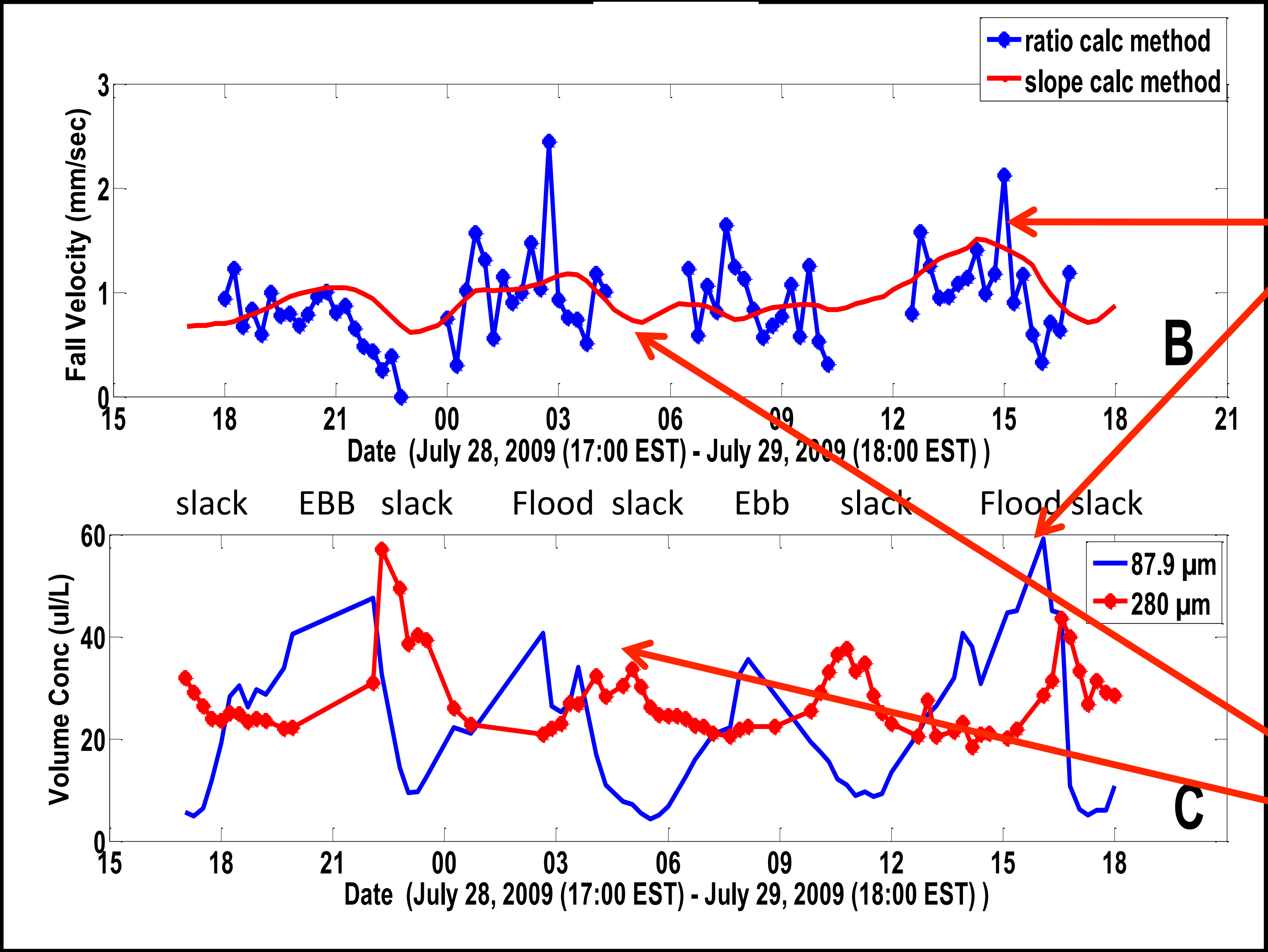
LISST Peak
LISST D50
RIPScam D16

Dominate floc size

~ 205 µm

LISST D84
RIPScam Peak
RIPScam D50

Settling Velocity and Volume Concentration



Pellets

Increase stress
Increase eff. Ws
Increase vol conc

Flocs

Decrease stress
Decrease eff. Ws
Increase vol conc

Conclusions and Future work

  - LISST Peak grainsize or D84 during maximum stress is the dominant resilient grainsize
  - LISST Peak grainsize or D50 during slack periods is the dominant flocculent size (larger will occur but at levels that are averaged out during burst averaging)
  - LISST D50 during maximum stress represents the dominant minimum flocculent size
  - Future work needs to look at LISST distributions during spring tide and episodic events to discover how the higher stress change the sizes and populations in suspension
  - Calibrations, with the Total Suspended Solids broken into resilient and non resilient portions, needs to be done to convert volume concentration to mass concentration so the density of the dominant particles can be determined

- Time averaged burst statistics can be used to determine the effective fall velocity of the sediment in suspension
  - Once the mass concentration of the dominant particles are identified further work can be done to calculate effective fall velocity of these size classes.

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